FDA Food Safety Research and the Role of USDA in the Identification and Control of *Salmonella*

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ARS Research Program

The Agricultural Research Service (ARS) is the inhouse research arm of the Department of Agriculture, that is, ARS performs all the research for the Department, except that carried out by the Forest Service. In addition the agency meets major research needs of industry stakeholders. This approximately $700M, is spread over 7 different areas: soil, water and air; plant sciences, animal sciences, commodity conversion and delivery, human nutrition research, integration of agricultural systems, and finally agricultural information and library services. The National Agricultural Library has now been combined administratively with the ARS for about 2 years. These research programs are carried out in 106 research locations and 35 worksites.

The ARS food safety program is funded at approximately $45 M and is carried out in 15 different locations. Food safety research in the ARS provides the means to ensure that the food supply is safe for consumers and that food and feed meet foreign and domestic regulatory requirements. This research includes four major areas, that is, microbial pathogens, mycotoxins, toxins found in plants, and chemical contaminants. Pathogen control is the largest research area, and *Salmonella* spp. are the major pathogens of concern, although they are being challenged by others, such as *E. coli* 0157:H7.

Food safety pathogen control includes both preharvest (animal production) and postharvest (slaughter and processing) research. The preharvest research is carried out at Beltsville, Maryland; Athens, Georgia; College Station, Texas; Clay Center, Nebraska; and Ames, Iowa; and the post harvest pathogen research is located at Philadelphia, PA; Beltsville, MD; Athens, GA; Clay Center, NE; and Albany, CA. Just as with all of ARS research, producers, industrial stakeholders, regulatory agencies, and most importantly, American consumers all benefit from ARS pathogen reduction research.

The ARS pathogen control research program includes methodology, information for regulatory decisions, and interventions. Methodology is new, faster, less expensive, more accurate, more precisely defining methods that can be used by either regulatory laboratories and/or producers. It does include some studies of sampling protocols, which are becoming far more important recently with the imminent publication of the FSIS regulations requiring HACCP in all inspected establishments. Information on which to base regulatory decisions includes models of bacterial growth kinetics, inactivation and survival. This is the type of information that is vital to the risk assessment procedures carried out by the FSIS. Finally the interventions are a wide ranging group of research projects which include development of management strategies, competitive colonization, vaccine development, water cleanup for reuse, irradiation, etc.

Current ARS swine research totals approximately $27.5 M. Like the whole of ARS research, swine research in ARS covers a broad range of topics. Of particular interest to this Symposium is a project on the Identification and Mapping of Genes involved with Parasitic Disease Resistance and Susceptibility and the research to develop controls against parasites, bacterial and viral diseases. Food safety is an important aspect of disease control and ARS research addresses trichinae, toxoplasma, and of course *Salmonella*, the subject of this symposium.

Historical Highlights of Identification and Control

The USDA has had a major role in identifying and controlling *Salmonella* in food starting with their isolation in 1885 as paratyphoid bacteria or the "hog cholera bacillus" by Salmon and Smith.[1] At that time Dr. Daniel E. Salmon, a veterinarian, was Chief of the Bureau of Animal Industry (BAI) of the USDA. The Bureau had been established by an Act of Congress on May 29, 1884, "to prevent the exportation of diseased cattle and to provide the means for the suppression and extirpation of pleuropneumonia and other contagious diseases of domestic animals." (The BAI was joined with other research units to form ARS during the reorganization of 1953.)[2] Dr. Theobald Smith, the other scientist associated with the isolation of *Salmonella* was a physician on Dr. Salmon's staff. Thus *Salmonella* started out as a multidisciplinary concern.[3]

The first identification of *Salmonella* coincided with the recognition of the need for inspection of meat to protect the public health. In the 1880s, there was domestic press coverage of the lack of hygiene in slaughterhouses, and some European countries restricted imports of American meat. In 1890, the first Federal Meat Inspection Statute was enacted but it applied only to exported meat; amendments were enacted in 1891 and 1895 to provide for inspection of meat for domestic markets, but they were weak and underfunded.[4] In 1906 following the publication of Upton Sinclair's novel, The Jungle, Federal meat inspection authority (P.L. 59-242) was considerably strengthened for all meat moving in interstate commerce, and the 1906 law as modified in 1967 (P.L 90-201) remains the basis for today's meat inspection.[5]

However, the identity of individual strains of the paratyphoid bacteria found by Salmon, and Smith was not clearly established until White in 1926 (Med. Res. Council, Spec. Rpt. Ser. 103, Brit.), recognized the importance of considering bacterial variation in relation to the antigenic analysis of paratyphoid strains. The confirmation and extension of White's work by Kauffman in 1941 (Die Bakteriologie der *Salmonella*-gruppe, Ejnor Munksgaard, Copengagen) resulted in the Kauffmann-White schema for the identification of paratyphoid bacteria. Since Salmon and Smith has isolated and described the first member of the group, the generic name of *Salmonella* was chosen and *Salmonella choleraesuis* became the type species.[1]

Salmonella (other than *Salmonella typhi*) first began to be recognized as a public health problem following World War II. D.H. Udall's The Practice of Veterinary Medicine, Fifth Ed., published by the author in 1947, in a discussion entitled, Paratyphoid in Sheep and Foals, stated that "Reports of (General Bacteriology, 1946), a number of food poisoning outbreaks have been plausibly attributed to *S. typhimurium*." Alverez (Textbook of Medicine, 1943) writes that the commonest cause of food poisoning due to bacteria or bacterial toxins is contamination of the food with living bacteria belonging to the *Salmonella* group.

In 1948 Edwards, Brunner, and Moran reported on the occurrence and distribution of the *Salmonella* types in the U.S. They included samples from humans, animals, water, and food in their study which was published as Kentucky Agricultural Experiment Station Bulletin 525. In 1951 McCullough and Eisele found that *Salmonella* strains isolated from market samples of spray dried egg powder readily induced salmonellosis in human volunteers. Fifteen years later in 1966 Brunner and Gillespie stated that "From the public health aspect it appears that meat, milk and eggs, products made from these materials, and domestic pets are the most important sources of *Salmonella* infection."[1]

There was public interest in *Salmonella* at that time particularly in animal feeds, and in 1959, the USDA undertook a survey and study of the problem, issuing findings in 1961.[6] This was followed by the first National Conference of Salmonellosis held at the National Communicable Disease Center of the U.S. Public Health Service in Atlanta, Georgia in 1964, and publication by the National Academy of Science of "An Evaluation of the *Salmonella* Problem - A Report to the

USDA and the FDA" in 1969. However, only further report writing[7] followed this initial surge of interest; and in fact, pathogen contamination of food was not on the front burner with the general public in this era dominated by chemical residue concern. *Salmonella* in meat and bone meal in animal feed did receive considerable attention, perhaps from the naive view that elimination of this source of *Salmonella* would solve the problem. However, Ben Pomeroy did demonstrate that turkeys could be raised free of *Salmonella* in Minnesota.[8]

The Food Safety and Inspection Service, particularly through Ralph Johnson, did understand that *Salmonella* were a public health problem and requested research from ARS in 1980 to help solve the problem, but, except for that relating to *S. enteritidis,* only post harvest research was conducted at that time. In 1985, ARS realized it was necessary to attack the problem of contaminated meat at the animal production level, and preharvest studies were initiated with broilers by Roy Blankenship at the Richard Russell Research Center at Athens, Georgia. Also in 1985, the Food and Nutrition Board of the National Research Council published, "Meat and Poultry Inspection, the Scientific Basis of the Nation's Program." This was really an epochal volume, but one which did not receive nearly enough publicity at the time.

Three years later, in 1988, the public became acutely aware of *Salmonella* following the recognition of *Salmonella* enteritidis infection of eggs. Also in 1988, ARS initiated research to prevent *Salmonella* in swine with Richard Wood at the National Animal Disease Center. But it was not until 1993, following the deaths of children from *E. coli* 0157:H7, that the whole food safety issue, including *Salmonella*, really began to command the nation's attention. Unfortunately, by that time, Congress was in no mood to provide any real increases for ARS or any other agency's pathogen control research programs. However, ARS has been able to redirect in-house resources at 5 locations to address *Salmonella* concerns in poultry and cattle as well as swine. Of particular success has been the development of a competitive exclusion culture of known identified normal gut flora that is able to exclude *Salmonella* spp. from the GI tract of newly hatched chicks (see D. Nesbit, Use of Defined Competitive Exclusion Cultures to Enhance Colonization Resistance to Enteric Pathogens, these Proceedings). Initial efforts are now being made to adapt this approach to swine.

REFERENCES

1. Hagan's Diseases of Domestic Animals, 1966, Fifth Ed.-D. Brunner and Gillepsie, pp. 217-240, Cornell University Press.
2. Agricultural Research- Its Organization and Management, A study by the Staff of the U.S. General Accounting Office, RED-76-92, April,1976.
3. Veterinary Medical Science and Human Health, p.28 - Committee on Government Operation, US Senate, August 10, 1961
4. J. F. Smithcors, The Veterinarian in America, p. 92, 1975, American Veterinary Publications, Inc.
5. CRS Report for Congress, Meat and Poultry Inspection: Background and Current Issues, 93-574-ENR, June 9, 1993
6. L.G. Morehouse and E.E. Wedman, 1961, *Salmonella* and Other Disease Producing-Organisms in Animal By-Products--A Survey, J. Am. Vet. Med. Assoc. 139:989.
7. Report to the Congress by the Comptroller General of the United States, *Salmonella* in Raw Meat and Poultry: An Assessment of the Problem, FDA, DHEW, APHIS, USDA, July 22, 1974. Recommendations for Reduction and Control of Salmonellosis, Report of the US Advisory Committee on *Salmonella*, January 1978, Food Safety and Quality Service, USDA.
8. B. Pomeroy, personal communications.